DISSERTATION

FOR

THE AWARD OF DEGREE

MASTER OF SCIENCE

In

Medical Imaging Technology

SESSION 2022-2024

Assessment of age-related changes in the width of the female pelvis

By

Sumit Singh

MSc. Medical Imaging Technology

Enrollment No (950122476)

DEPARTMENT OF RADIO-DIAGNOSIS

SANTOSH DEEMED TO BE UNIVERSITY

NO. 1, SANTOSH NAGAR, GHAZIABAD-201009,

DELHI NCR, INDIA

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This is to certify that the statistical analysis component of the thesis titled "**Assessment of age-related changes in the width of the female pelvis"** done by **Mrs. Kirti Bharadwaj** in the **Department of Central Research Facility** at Santosh Medical Collage and Hospital, Ghaziabad, has been conducted under my direct guidance and supervision.

All the statistical calculations of the study are authentic and correct to the best of my knowledge.

Name: Mrs. Kirti Bharadwaj

Designation: Assistant professor and Bio-statistician

Department of Central Research Facility

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I, Sumit Singh, at this moment, declare that the present thesis entitled "**Assessment of age-related changes in the width of the female pelvis**" submitted by me to Santosh Deemed to be University is original research work I also at this moment declare that there is a similarity in contents found (), after plagiarism check.

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ACKNOWLEDGEMENT

My first and foremost task is to almighty to present me this opportunity to complete this project.

With great pride and pleasure, I express thanks to **Dr. Ashok Kumar Sharma**, Professor and Head of Department for being undertaking this project.

I am thankful & grateful to my project guide **Ms. Neelam Rao Bharti,** Assistant Professor, who has my constant source of inspiration, who has given me kind advice, encouragement and guidance throughout the project "**Assessment of age-related changes in width of female pelvis"** and helping & guiding to complete the project successfully.

I would also like to express my gratitude towards **Mr. Himanshu Mishra**, Assistant Professor and our technical staff **Mr. Ramesh Chandra Babu, Mr. Pawan Goel and Mr. Mathews Kcherian,** who has always been encouraging and have been a guiding support to me in this journey.

I also to express sincere thanks to my college batch mates, Family and friends for helping and supporting me to complete this project with great success.

I also thank to all the faculty and staff members of the **Department of Radio-Diagnosis** for helping and guiding me to completing this project with great success.

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ABBREVIATION

S. No	Abbreviations	Full Form
1.	CT	Computed Tomography
2.	SI Joint	Sacro Iliac Joint
3.	ASIS	Anterior Superior Iliac spine
4.	PSIS	Posterior Superior Iliac Spine

ABSTRACT

The female pelvis undergoes morphological changes throughout life, particularly in width, which can influence various physiological and clinical outcomes. This study aims to assess age-related changes in pelvic width among women and their potential implications for health. A cross-sectional analysis was conducted on a sample of women aged 10 to 65 years, Pelvic width was measured at critical anatomical points, ASIS to Right SI joint, ASIS to LEFT SI joint using radiographic imaging and 3D scanning techniques.

The findings reveal that pelvic width increases significantly from young adulthood to middle age, peaking between 40 and 50 years. This enlargement is likely linked to reproductive adaptations, as a wider pelvis facilitates childbirth. However, a gradual reduction in width was observed in women over 60 years, which may be attributed to age-related bone resorption and changes in hormone levels, particularly the decline in estrogen post- menopause. The contraction of the pelvis in later life could have clinical consequences, such as increased susceptibility to pelvic floor dysfunction, osteoporosis, and fractures, impacting mobility and quality of life in older women.

Understanding the dynamics of pelvic width across the lifespan is essential for anticipating health issues associated with aging. The study underscores the need for further research on interventions that could mitigate the negative effects of pelvic narrowing in elderly women, as well as for preventative strategies in younger populations.

Keywords:

Female pelvis, pelvic width, age-related changes.

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Chapter 1

INTRODUCTION

The pelvis and the spine constitute a system balancing human skeleton in its vertical posture, bipedal locomotion, and sitting position [1-7]. Aimed at maintaining a relatively fixed gravity line, the pelvis compensates age-related changes in the vertebral column.

The assessment of age-related changes can provide information for a better understanding of pelvic floor diseases associated with aging. Clinical studies demonstrate that the risk of development of pelvic organ prolapse, urinary and fecal incontinences increase with age

(8,9,25)

The pelvic floor dysfunction and the pelvic organ prolapse are observed more often in females with a wider [10 – 12] and more horizontally oriented pelvic inlet [13], a wider distance between ischial spines [14], and a longer sagittal diameter of the outlet [13].

The pelvis plays important functions in (1) locomotion, as body weight is transmitted to the lower limbs through the pelvic girdle, (2) childbirth, as the human neonate must pass through the birth canal, which lies within the pelvic girdle as the baby exits the body, and (3) support of abdominal organs which are held up by both the pelvic floor musculature and the pelvis itself.

The human pelvis has been reported to change in shape throughout adult lifetime, and also the expression of parturition scars, or “pelvic features”, increases with age. However, little is known about the causes and timing of these changes.

The main explanation for the development of these pathologies was related to changes in the soft tissues of the inferior wall of the pelvic cavity. (15,16)

However, some characteristics of the bony pelvic shape can contribute to the development of the diseases. (10,13,14)

The determination of race, sex, age and stature in the living or dead is an imperative element of any medico-legal investigation. Sexing of the remains is a cornerstone in forensic medicine as it primarily narrows down the pool of possible victim matches. (17,18)

Sex estimation is the classification of an individual as either male or female. Although there are only two biological sexes exist in humans, sex estimation of a human skeleton remains a challenge. [19]

The hands, especially the metacarpal bones, have been addressed for sex estimation with varying results in terms of accuracy. (20)

The human pelvis, a vital component of the skeletal system, plays a crucial role in various physiological functions and structural support. In the context of female anatomy, understanding the changes in pelvic width throughout different stages of life is essential for both clinical and research purposes. This introduction explores the assessment of age-related changes in the width of the female pelvis through advancements in computed tomography (CT) technology,

the history of CT imaging, the evolution of CT generation, and the fundamental anatomy of the pelvic bone.

1.1 **The Importance of Pelvic Width in Female Anatomy**

The pelvic bone, or os coxae, consists of three fused bones: the ilium, ischium, and pubis. In females, the pelvis is typically wider and more circular compared to males, an adaptation that facilitates childbirth. This pelvic width is not static; it undergoes significant changes over a woman's lifetime due to various factors including hormonal influences, childbirth, and age-related bone density changes. [1],[2],[20],[21],[22][23].

Monitoring these changes is crucial in clinical practice. A wider pelvis can indicate normal developmental variations, while significant deviations might suggest pathological conditions or be of clinical interest for surgical planning. For instance, during menopause, hormonal changes can lead to alterations in bone density and structure, impacting the pelvic width and potentially affecting overall mobility and health. [1],[2],[20],

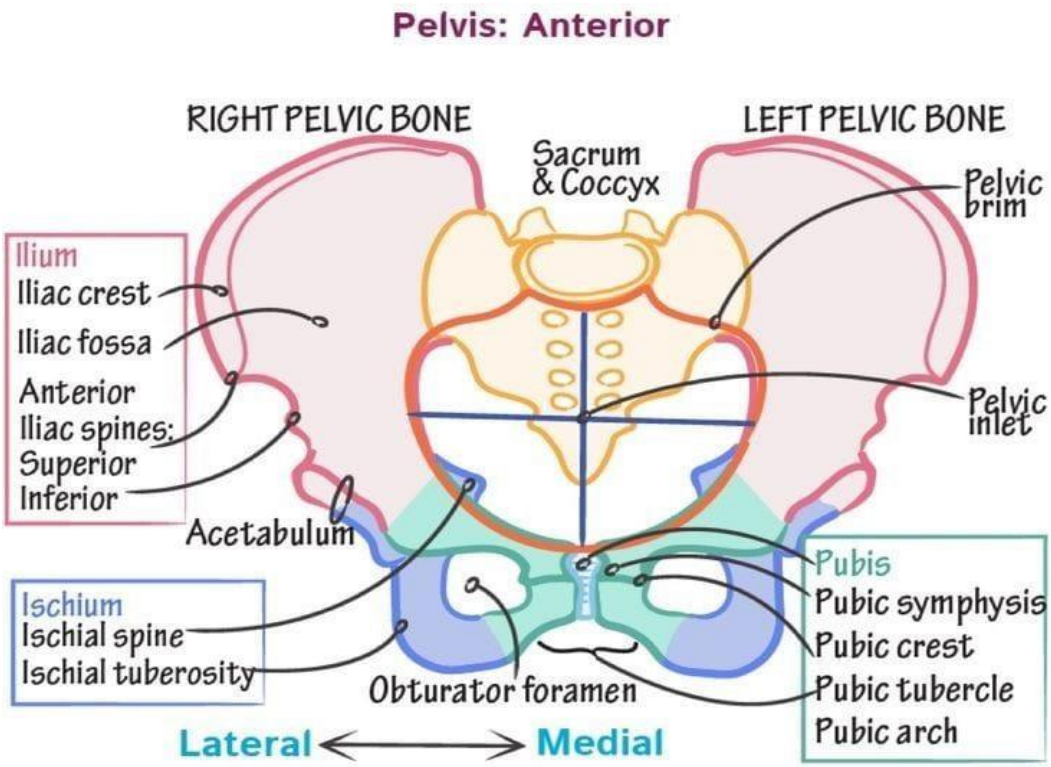


Fig 1 Pelvis Anterior

1.2. History of Computed Tomography (CT) Imaging

Computed Tomography (CT) imaging revolutionized diagnostic medicine by providing detailed cross-sectional images of the body. The technology was first developed in the early 1970s by Sir Godfrey Hounsfield and Allan Cormack, whose pioneering work earned them the Nobel Prize in Physiology or Medicine in 1979. Early CT scanners, also known as CT scanners, produced images with relatively lower resolution compared to modern technology. These early systems used a single x-ray source and detector, rotating around the patient to capture images from multiple angles, which were then reconstructed to form detailed cross- sectional images.[17],[18],[19]

Fig. 2 CT Machine

The advent of CT imaging marked a significant leap forward in understanding complex anatomical structures, including the pelvis. This technology allowed for non-invasive visualization of internal structures, greatly enhancing diagnostic accuracy and providing anew perspective on anatomical changes associated with age, disease, and trauma.[19]

1.3. Evolution of CT Generation

CT technology has undergone substantial advancements since its inception. The evolution ofCT scanners is categorized into several generations, each improving upon the previous in terms of image quality, speed, and resolution.[17],[19]

First Generation: -The initial CT scanners, developed in the 1970s, utilized a single x-ray tube and detector pair, with images obtained in a pencil-beam fashion. These early scannerswere relatively slow and required significant time for data acquisition and image reconstruction.[18],[19]

Second Generation: -Introduced in the late 1970s, second-generation CT scanners featured multiple detectors and fan-beam technology, which significantly reduced scan times and improved image quality. This generation laid the groundwork for more advanced imaging techniques.[19]

Third Generation: -The third generation, emerging in the 1980s, incorporated a rotating x-ray tube and detectors, allowing for continuous acquisition of images and further improvements in speed and resolution. This generation marked the beginning of spiral or helical CT scanning, which enabled the acquisition of voluminous data in a single breath-hold.[17],[19]

Fourth Generation: - Fourth-generation CT scanners, developed in the late 1980s and early 1990s, featured a fixed detector array with a rotating x-ray tube. This configuration eliminated the problem of image artifacts and allowed for even faster scanning.[18],[19]

Fifth Generation and Beyond: -The advent of multi-detector row (MDCT) and cone-beam CT technologies further revolutionized imaging capabilities. MDCT scanners, introduced in the late 1990s, incorporate multiple rows of detectors, allowing for high-resolution imaging and the acquisition of detailed 3D datasets. Cone-beam CT, developed in the early 2000s, provides high-resolution images with a larger field of view, commonly used in dental and maxillofacial imaging.[19]

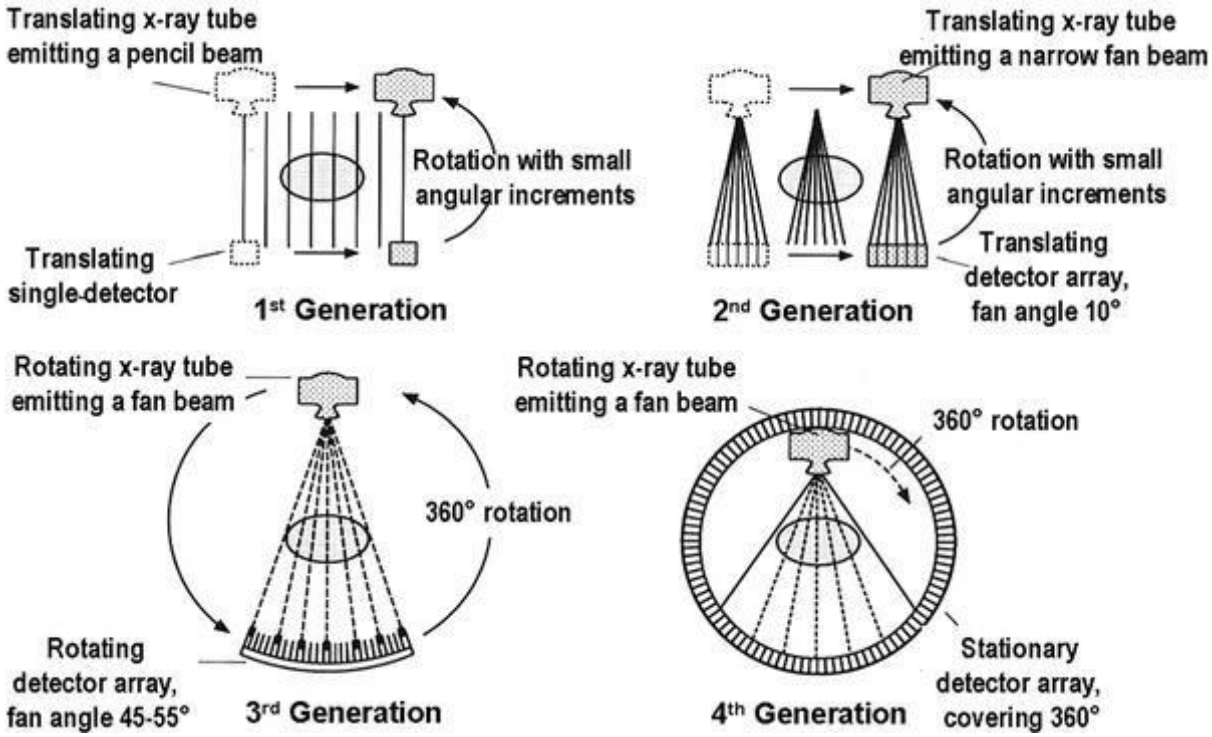

Translating x-ray tube emitting a pencil beam
Rotation with small angular increments
Translating single-detector
1st Generation
Translating x-ray tube emitting a narrow fan beam
Rotation with small angular increments
Translating detector array, fan angle 10°
2nd Generation
Rotating x-ray tube emitting a fan beam
360° rotation
Rotating detector array, fan angle 45-55°
3rd Generation
Rotating x-ray tube emitting a fan beam
360° rotation
Stationary detector array, covering 360°
4th Generation

Fig. 4 Generation of CT

1.4. Pelvic Bone Anatomy and its Relevance in CT Imaging

The anatomy of the pelvic bone is complex, with significant implications for CT imaging. The pelvis can be broadly divided into the bony pelvis and the pelvic cavity. The bony pelvisconsists of the ilium, ischium, pubis, and sacrum, while the pelvic cavity houses organs such as the bladder, rectum, and reproductive organs.[2],[3]

In females, the pelvic anatomy is designed to accommodate childbirth, resulting in a wider and more circular pelvic inlet and outlet compared to males. The pelvic width is defined by the distance between the ischial spines, the distance between the pubic symphysis and the sacrum, and the transverse diameter of the pelvic cavity. These measurements are critical in assessing age-related changes, as alterations in pelvic width can influence clinical outcomes and surgical approaches.[22],[23]

CT imaging provides detailed visualization of these anatomical structures, enabling precise measurement of pelvic width and identification of age-related changes. For instance, the lossof bone density with age, known as osteoporosis, can lead to changes in the structural integrity of the pelvis, affecting its width and overall morphology.[14],[16]

1.5. Age-Related Changes in Pelvic Width

As women age, several factors contribute to changes in pelvic width. Hormonal changes during menopause lead to decreased bone density and alterations in bone structure, which can impact pelvic dimensions. Additionally, previous pregnancies and childbirth can affect pelvicmorphology, potentially leading to increased pelvic width or altered shape.[6],[11],[16]

CT imaging is instrumental in assessing these changes, providing insights into the impact of aging on pelvic anatomy. By analyzing cross-sectional images and measuring pelvic width at various stages of life, researchers and clinicians can better understand the implications of age- related changes on health and function.[12]

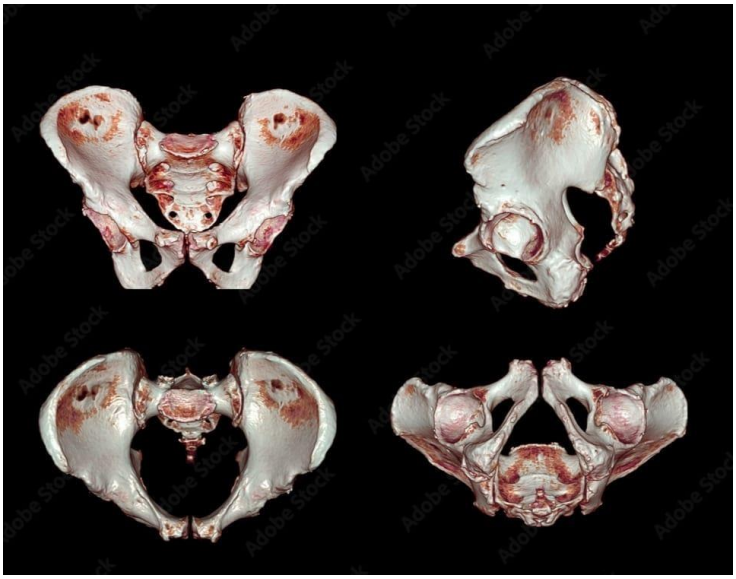


Fig.5 Pelvis

1.6. Clinical Implications and Future Directions

Understanding age-related changes in pelvic width is essential for various clinical applications, including orthopedic surgery, obstetrics, and gynecology. Accurate measurement of pelvic dimensions can guide surgical planning, improve the management ofpelvic fractures, and enhance prenatal care.[5],[8],[9]

Future advancements in CT technology, such as higher resolution imaging and improved algorithms, will further refine our ability to assess pelvic changes. Additionally, the integration of CT data with other imaging modalities, such as MRI and 3D modeling, willprovide a more comprehensive understanding of pelvic anatomy and its alterations with age.[5],[9],[11],24

In conclusion, the assessment of age-related changes in the width of the female pelvis through CT imaging involves a multidisciplinary approach, encompassing the history of CT technology, advancements in imaging techniques, and the intricate anatomy of the pelvis. As technology continues to evolve, so too will our ability to understand and manage the dynamic changes in pelvic anatomy throughout a woman's life.[6],[8]!

Chapter 2

Aim and Objective

Aim of the study

The study aimed to evaluate the Age -related changes in width of female pelvis.

Objectives –

1.) Understanding Aging Process: Investigating how the female pelvis changes over time can contribute to our understanding of the aging process and its impact on skeletal structures.

2.) Clinical Relevance: Identifying age-related pelvic changes is crucial for healthcare professionals in diagnosing and managing conditions such as pelvic organ prolapse, urinary incontinence, and obstetric complications.

3.) Anthropological Insights: Examining age-related variations in pelvic width provides valuable insights into evolutionary biology, human adaptation, and population health.

NEED OF STUDY

This research was made with the aim to Assessment of age-related changes in the width of the female pelvis

The assessment of age-related changes in the width of the female pelvis is a critical area of study in both anthropology and medicine. As women age, their pelvic structure undergoes significant transformations due to a variety of factors including hormonal changes, childbirth, and overall physical activity. The width of the female pelvis, particularly the pelvic inlet and outlet, is crucial for reproductive health, influencing both pregnancy and childbirth outcomes.

Research indicates that the female pelvis typically widens during puberty to accommodate reproductive functions, reaching its maximum width in early adulthood. However, with advancing age, changes in bone density and muscle elasticity can lead to alterations in pelvic width. Postmenopausal women, for instance, often experience a narrowing of the pelvic dimensions due to decreased estrogen levels, which impact bone density and joint flexibility.

Furthermore, the study of pelvic width changes can help in understanding various health implications, such as the risk of pelvic organ prolapse and other pelvic floor disorders, which are more prevalent in older women. Analyzing these changes also aids in forensic science for age estimation and in designing medical interventions tailored to different age groups. Overall, the assessment of age-related changes in pelvic width provides valuable insights into women's health and aids in improving medical care across different stages of life.

Chapter 3

REVIEW OF LITERATURE

1. **Research by Suguru Torimitsu etc. all.,06 February 2024** Previous studies focused on analyzing morphological differences in the pelvis between various populations, with computed tomography (CT) being increasingly used as a tool for such investigations. Researchers had previously demonstrated the potential of CT scans in capturing detailed anatomical landmarks of the pelvis, which could then be used for comparative studies across different populations. Prior research also indicated that pelvic morphology could vary significantly between different ethnic groups, highlighting the potential for population-specific anatomical markers. In several studies, volumetric reconstruction of pelvic CT data was employed to obtain precise measurements and landmarks, which were then used to assess population affinity. Machine learning techniques, such as random forest modeling (RFM) and support vector machine (SVM), had been utilized in the past to enhance classification accuracy of population affinity based on pelvic measurements. These methods demonstrated varying degrees of success, with sex-specific models generally outperforming sex-mixed models in classification tasks. The accuracy rates in some models exceeded 80%, while certain sex-specific models achieved even higher rates, particularly in distinguishing between Japanese and Western Australian populations. Past research also highlighted the effectiveness of using CT data for population affinity classification, noting that pelvic morphology could serve as a reliable indicator of ethnic origin. Studies involving Japanese and other East Asian populations often revealed distinct pelvic traits that allowed for more accurate classification when compared to Western populations. While cranio-facial morphology had long been the traditional focus for population affinity studies, the growing use of CT for pelvic analysis provided new insights and offered a viable supplement to existing methods. Additionally, previous investigations emphasized that sex-specific differences in pelvic morphology played a crucial role in improving the accuracy of classification models. The use of machine learning algorithms in such studies marked a significant advancement in forensic anthropology, enabling more precise predictions of population affinity based on skeletal measurements. These findings collectively underscored the importance of CT imaging as a valuable tool for both anthropological and forensic research, offering an alternative to traditional methods reliant on cranial morphology.

2. **A systematic review study by Valdino etc. all., 30 june 2023.,** The CT Scan (Computed Tomography) has been a pivotal tool in the medical field for observing and diagnosing patients. Over time, the CT scan technology evolved through seven generations, enhancing its efficiency and effectiveness. Initial scans required about 25 minutes, but advancements reduced this to mere seconds. Improvements included higher resolution imaging with minimalnoise, simplified calibration, and reduced radiation dosage for patients. A significant milestone was the development of multi-slice CT scanners, which produced clearer images with superior resolution compared to earlier versions. The technology continued to evolve, with efforts focusing on creating more compact and streamlined designs. These advancements aimed to automate the scanning process, making it more efficient and user-friendly. Despite the remarkable progress, ongoing research and development seek to further enhance the CT scan's capabilities. As the technology advances, the medical field anticipates even more sophisticated and accessible CT scanners, promising better diagnostic tools and improved patient care. The evolution of the CT scan underscores its crucial role in modern medicine and its potential for future innovations.

3. **A research by Waltenberger, etc. all, published on February 2022 .,** investigated age- dependent changes in pelvic shape during adulthood. Their research confirmed that the humanpelvis changes shape throughout adult life, with a more significant magnitude of change in females than in males. The authors analyzed a modern sample of 167 adult individuals, accounting for variables such as age, parity, and cause of death. They identified three distinct phases of pelvic shape changes in females: the reproductive period (17 to approximately 37- 40 years), the post-reproductive but premenopausal period, and the postmenopausal period (after 50 years). In contrast, males exhibited two phases of relatively similar pelvic shape changes. The expression of parturition scars increased in females until around 40 years of age and then remained stable, whereas males showed only a slight increase in feature expression. The authors hypothesized that these changes result from a combination of hormone-mediated and mechanically induced bone remodeling. They suggested that estrogen-induced and pregnancy-related bone remodeling are dominant factors in premenopausal women, while mechanical factors drive changes in men and postmenopausal women. The study posited that the continual widening of the birth canal during the reproductive period facilitates childbirth but is unlikely to have evolved specifically as an obstetric adaptation. Instead, the conserved endocrine system and estrogen-induced pelvic bone remodeling existed before the significant increase in neonatal brain size in humans, potentially fine-tuned by selective forces in the human lineage.

4. **A Study by Rosy Setiawati etc. all, published on14 September 2022.,** This study aimed to determine pelvic anthropometry characteristics and create a logistic regression formula for adult sex identification using three-dimensional pelvic computed tomography images. It was an observational analytical study with a retrospective regression and cross-sectional approach.The population consisted of patients at the Radiology Installation of Dr.Soetomo General Academic Hospital, a referral hospital in East Indonesia, who underwent 3D pelvic CT examinations from September to December 2019. Age distribution and pelvic measurements data were collected and analyzed statistically. The study included 204 samples. All radiologiccomponents, except the transverse diameter of the sacral segment ($p=0.180$), showed significant differences between sexes ($p<0.05$). The conjugate pelvic inlet diameter (CPID), left innominate height (LIH), and subpubic angle (SPA) were significant for the regression formula to determine an adult's sex using 3D pelvic CT. The formula predicted female sex with a calculation result greater than 0 and male sex with less than 0. The logistic regression model showed high validity (91.05%), with 100% sensitivity for identifying male sex and 81.1% specificity for identifying female sex. This study highlighted differences in radiometric variables in pelvic anthropometry among adult Indonesians, suggesting the potential of 3D CT imaging in developing accurate pelvic models for sex identification.

5. **A Research by Naoya Inagak etc. all,published on 29 Mar 2022.,**In this study, researchersaimed to investigate the bone mineral density (BMD) variations in the pelvis by measuring Hounsfield unit (HU) values in the cancellous bone of both the acetabulum and pelvic ring. The study enrolled 61 young patients with high-energy trauma and 154 older patients with low-energy trauma, excluding those with pelvic implants or who had died. CT scans of the pelvis were analyzed to measure HU values in seven distinct areas: the pubic bone, acetabulum walls and roof, ischial tuberosity, body of the ilium, and the third lumbar vertebra.The results showed that the highest HU values were observed in the roof of the acetabulum for both age groups. However, HU values were generally higher in the ischial tuberosity and body of the ilium but lower in the pubic bone and anterior wall for the older patients compared to the younger cohort. The study concluded that HU values varied significantly across pelvic areas and decreased with age, which might explain the distinct patterns of acetabular fractures in older patients and could inform surgical approaches for such fractures.

6. **The Scott Telfer etc. all, published on2021 Mar.,**The Unstable pelvic ring fractures represented severe and intricate injuries, with surgical fixation proving challenging and often complicated by early failure. Difficulties in securely fixing screws in low-density bone contributed to these complications. The literature provided limited insight into how bone

density distribution across the pelvic bones varied with age and sex. In this study, 60 sets of calibrated bone density measurements, obtained from clinical CT scans of the pelvis, were utilized. Three-dimensional models of the innominate bone were created, and the effects of age and sex on cortical bone density were examined. The study identified overall trends and regions significantly influenced by these factors. The mean density loss across the innominatebone was 1.6 mg/cc per year. Specific areas, such as the pubic body, iliac fossa, posterior ilium, and anterior inferior iliac spine, exhibited density loss rates up to three times higher than other regions. Sex-specific effects were notable in the posterior pubic root, anterior pubicbody, and iliac crest. Despite general trends, variability between individuals persisted, underscoring the need for personalized planning tools in pelvic fracture repair.

7. **A Research byRosy Setiawati, etc. all, postedon 19 May, 2021.,** In previous research, pelvic bones were established as the most reliable indicator of sex in adults due to their marked sexual dimorphism. Advances in medical imaging, particularly Computed Tomography (CT), have enabled a quantitative analysis of modern human variation. The objective of this study was to determine the anthropometric characteristics of the pelvis and develop a logistic regression formula for adult sex identification using pelvic 3D CT scans. Conducted as an observational analytical study with a retrospective and cross-sectional approach, the research examined data from patients at Dr.Soetomo General Hospital in Surabaya, Indonesia, who underwent pelvic 3D CT from September to December 2019.The study analyzed pelvic measurements and age distribution from a sample of 204 patients, with an average age of 50.23 ± 14.36 years. Significant sex differences were found in all radiologic components except for the transverse diameter of the sacral segment. Eta tests revealed that APOD, CPID, LIH, TPO, and SPA showed the strongest correlations. A logistic regression formula was developed: sex = (0.125 x CPID) – (0.180 x LIH) + (0.078 x SPA) + 8.912. Results indicated a high validity of 91.05%, with 100% sensitivity for male identification and 81.1% specificity for female identification. The study demonstrated that 3D-CT pelvic models provide a more accurate and sensitive method for sex determination in adults.

8. **A study by Jan M. Novak etc. all, 11 May 2020.,** It was noted that the adult pelvis is sexually dimorphic, a trait that emerges during puberty, as juvenile skeletal differences are minimal. Animal models and case studies on gender dysphoria treatment provided evidence that estrogens stimulate the pelvic growth plates, causing morphological changes. In males, obesity during puberty was linked to hypogonadism, characterized by low testosterone and high estrogen levels. Research aimed to understand how adolescent obesity affects adult pelvic morphology, considering androgen

and estrogen status. A sample of 238 individuals, with an average age of 15.2 years at enrollment and 23.3 years at follow-up, was observed. Measurements included anthropometry, body composition via bioimpedance analysis (BIA), and salivary hormone levels. Results showed a strong positive correlation between body fat percentage and relative pelvic breadth in adulthood for both males and females. The adult pelvic breadth was identified as a sensitive and specific marker for adolescent obesity. A regression model incorporating testosterone, estradiol to testosterone ratio, and body fat accounted for 54.8% of pelvic breadth variability in males. The study concluded that a historyof adolescent obesity is linked to wider adult pelvic dimensions, demonstrating the lasting impact of obesity on skeletal morphology.

9. **A Study Marc-Daniel Ahrend etc. all, on January 2020.,** The Artificial bone models (ABMs) have been widely utilized in orthopaedics for biomechanics research, implant development, and educational purposes. However, most commercially available ABMs represent European morphology and may not accurately depict Asian anatomy. This study aimed to develop the first Asian ABM of the pelvis and compare it with an existing pelvic ABM (Synbone®; Caucasian male). Clinical computed tomography (CT) scans of 100 adultpelvises (50 male, 50 female) of Malay, Chinese, and Indian descent were acquired and segmented. Landmarks were placed on the models, and three 3D statistical pelvic models (overall, male, female) were generated. Principal component analysis was used to analyze anatomical variations. Distances between key anatomical landmarks (ASIS, AIIS, CV, DT) were measured to identify gender-related differences and to compare with the existing ABM. Principal component analysis revealed significant variability in pelvic shape and size. Female and male models were similar in ASIS and AIIS measurements but differed significantly in CV and DT. Comparison with the existing ABM showed significant differences in ASIS, AIIS, and CV measurements, with both models being similar in DT. The Asian model was smaller overall compared to the existing ABM. Notable gender- and size-dependent anatomical variations were identified within the Asian population, while variations among Chinese, Malay, and Indian descents were minimal. The study highlighted substantial differences between the Asian ABM and the existing ABM, as well as between genders within the Asian population. The development of an Asian- and gender-specific ABM is essential for accurate research, biomechanics studies, and implant development tailored to this population.

10. **A study by Ika Ruriana etc. all, 9 December 2020.,** Previous anthropological assessments utilized pelvic indices as supplementary measurements to explore human variation. Early studies incorporated

various methods, but the advent of computed tomography (CT) significantly enhanced these assessments. Researchers had used CT to examine modern human pelvic morphology, offering more detailed insights compared to traditional methods. CT allowed for the extension of osteological resources to a broader range of researchers, providing more quantitative data for anthropometric evaluations. Several studies emphasized the importance of CT in capturing variations in pelvic anatomy, facilitating a more accurate analysis of population differences in both sexes. Additionally, researchers found that pelvic anthropometry through CT scans yielded valuable information for studies on age distribution, sex differentiation, and skeletal morphology, underscoring the need for astandardized approach in radiological assessments. Furthermore, previous research recognized the potential of CT technology in advancing osteological analysis by improving the precision of measurements in skeletal structures. Theuse of 3D imaging in pelvic assessments had been shown to provide superior data comparedto 2D methods, enhancing the understanding of pelvic dimensions and their relation to demographic variables such as age and sex. These findings suggested that CT scans were indispensable in modern anthropometry, offering detailed radiometric variables essential formore comprehensive anthropological studies.

11. **The study by Figueroa C etc. all., on 20 Aug 2019 .,** The pelvis, comprising the right and left hip bones formed by the pubis, ischium, and ilium bones, along with the midline sacrum and coccyx, has been extensively studied. The hip bones converge anteriorly to form the pubic symphysis and unite posteriorly with the sacrum at the sacroiliac joints. This entire structure, known as the bony pelvis or pelvic girdle, creates a basin-shaped ring that integrates the axial and appendicular skeletons. Researchers have noted the bony pelvis's critical role in various bodily functions, acting as a transitional zone for neurovascular structures between the abdomen and lower limbs. It also serves as a junctional point for forces between the spine and lower limbs during movement and houses essential visceral structures, including the female reproductive organs, urinary bladder, and rectum. This literature underscores the pelvis's significance in both structural support and the protection of vital internal organs.

12. **A Review Study by Mahadevan, Vishy. , July 2018**, This literature review on pelvic anatomy and its associated functions revealed the complex role of the pelvis inboth support and protection. As described, the pelvis comprised the right and left hip bones (ossa coxae) and the sacrococcygeal region of the vertebral column, forming a robust bony ring. This structure was essential for linking the axial skeleton with the appendicular skeleton via the pelvic girdle, which articulated with the

femoral heads. The primary functions of the pelvic girdle included weight transmission from the upper body to the lower limbs during movement and standing, as well as supporting the body when seated. The pelvis also played a critical role in muscle attachment, particularly for the gluteal muscles and those supporting the abdominal wall.Protection of the pelvic viscera, vessels, and nerves was another vital function of the pelvis, highlighting its role in safeguarding delicate structures within the pelvic cavity. Despite its robustness, pelvic fractures, though relatively rare, typically resulted from high-energy traumas such as severe vehicular accidents or substantial falls. Effective orthopaedic intervention for such fractures necessitated a thorough understanding of pelvic anatomy and the associated management of intra-pelvic injuries. The review underscored the significance of the pelvic ring's anatomy in the context of both injury prevention and treatment, reflecting the complex interplay between the structural integrity and functional demands placed on the pelvis.

13. **A research by Eden Johnstone-Belford etc. all, on March 2018,** Previous studies emphasized the critical role of forming a biological profile, particularly the estimationof sex and age, as the initial task in forensic anthropological analysis of skeletal remains. Researchers increasingly recognized the value of studying age- and sex- related morphoscopic features through high-resolution multiple detector computerizedtomography (MDCT) scans. The focus on using advanced imaging techniques, such as MDCT, reflected a growing trend in the field to enhance the accuracy of sex estimation, especially through methods like the Phenice technique.Earlier research had shown the potential of MDCT scans for capturing detailed pelvic morphology, which is essential for accurate sex estimation. Studies frequently used 3D volume- rendered models reconstructed from MDCT scans to assess key pelvic traits such as the ischiopubic ramus, ventral arc, and subpubic concavity. Previous findings had consistently demonstrated that the Phenice method, which relies on these traits, could be effectively applied in forensic contexts when analyzed using MDCT data.The precision and reliability of this method were often confirmed through intra-observer accuracy tests, which typically yielded Kappa values above 0.81 for each morphological attribute assessed. This indicated a high level of observer agreement in identifying and measuring the relevant pelvic traits. Consistent with earlier research, the ventral arc emerged as the most accurate individual trait for sex estimation, with an overall accuracy rate of 86.61%. However, some studies highlighted an age-related bias in classification accuracy, suggesting that the method might perform differently across various age groups.When combining the three key pelvic traits—ischiopubic ramus, ventral arc, and subpubic concavity—researchers reported an overall accuracy rate of 92.24% for sex estimation using the Phenice method. This

high degree of accuracy demonstrated that the method was reliable when applied to MDCT scans and could be successfully used for forensic identification in specific populations, such as Western Australians. Earlier literature consistently affirmed that the Phenice method, when supplemented with advanced imaging techniques like MDCT, provided a valuable and accurate tool for sex estimation in forensic anthropology.

14. **A systematic review study by Auerbach , Benjamin M. Auerbach etc. all 29 August 2018.,** The studies have associated females who died in young adulthood with narrower obstetric pelvic dimensions, presumably linked to obstetric insufficiency, although this causalrelationship remains unresolved. In this study, researchers examined whether females from groups living at higher latitudes exhibited this pattern, as high-latitude groups tend to have larger pelvic dimensions compared to groups previously studied. These patterns were also compared with males. The study assessed whether evidence existed for younger ages-at-death in females as a response to natural selection against narrower true pelvis dimensions. Methods involved measuring 14 pelvic dimensions in 327 adults (188 females, 139 males) from archaeological sites in mid-latitude and high-latitude North America. Individuals were categorized as "young" or "not young" based on age-at-death. Comparisons across latitude, sex, and age-at-death groups were conducted using ANOVAs and scaled variance, and evidence for selection was examined with F-tests. Results indicated that pelvic dimensions were larger in high-latitude females and males. Females who died at younger ages had smallerpelvic canals than older individuals, particularly in the mediolateral inlet and anteroposterior outlet dimensions, a pattern not observed in males. Variance in all pelvic dimensions was equivalent between the two female age-at-death groups.Conclusions revealed narrower obstetrical dimensions in the female pelvis among individuals who died younger. However, the statistically equivalent variances between the two female age-at-death groups did not support natural selection on pelvic dimensions as a factor for younger ages at death. Instead, researchers argued that the difference resulted from continued growth due to pelvic remodeling in females, but not males, after early adulthood.

15. **A study by Vishy Mahadevan etc. all., published on July 2018.,** The term pelvis referred to the irregular but complete bony ring comprising the right and left hip bones (ossa coxae) anteriorly and at the sides, and the sacrococcygeal part of the vertebral column posteriorly. Massively constructed, the two hip bones were firmly united anteriorly at the pubic symphysis, together forming the pelvic girdle. This girdle articulated with the femoral heads, linking the vertebral column (axial skeleton) to the

femora (appendicular skeleton). The primary functions of the pelvic girdle included transmitting weight from the upper body to thelower limbs during locomotion and standing, and supporting the upper body's weight when seated or stationary. Another crucial function was to provide attachment for the powerful muscles, such as the gluteal muscles, that acted on the lower limb and supported the abdominal wall. Additionally, the bony pelvis offered protection to the delicate viscera, vessels, and nerves within the pelvic cavity. Pelvic fractures, relatively uncommon, typically resulted from high-energy traumatic events like forceful collisions in road traffic accidents or major crush injuries. Effective orthopedic management of pelvic fractures and associated intrapelvic injuries required a thorough understanding of the pelvic ring and cavity anatomy.

16. **The study by Wobser AM etc. all., on 24 Aug 2018.,** The pelvis, a group of fused bones, was considered the first step in linking the axial skeleton to the lower appendages. The lumbar spinal column directly communicated with the pelvis, forming the connection betweenthe axial skeleton and the appendicular skeleton. The femur connected to the pelvis at the acetabulum, a bony ring formed by the fusion of the ilium, ischium, and pubis. The primary function of the pelvis was to support locomotion by providing attachment points for muscles, tendons, and ligaments. Stiff joints bound the axial skeleton to the pelvis, while a relatively free-floating ball and socket joint between the femur and the acetabulum allowed maximal mobility. In examining the pelvis, distinctions were made between the "pelvic spine" and the "pelvic girdle." The pelvic girdle, or os coxae, consisted of the ilium, ischium, and pubis, fused into a ring closed anteriorly by the pubic symphysis and posteriorly by the sacrum at the sacroiliac joints. The pelvic spine comprised the sacrum and coccyx. Together, these structures formed the bony pelvis, essential for both stability and movement.

17. **A Study by Oksana Kolesova etc. all, acceptedon November 3, 2017.,** The aimed of the investigate the age-related changes in the lesser pelvic architecture of both females and males using computed tomography pelvimetry. Previous research has mainly concentrated on changes in the sagittal plane, thus the goal was to explore changes in both the sagittal and coronal planes and to assess sexual dimorphism in these trends. Conducted at Riga East University Hospital, Clinical Center “Gailezers,” Latvia, the study involved 211 females (18 to 84 years) and 181 males (18 to 82 years). Computed tomography pelvimetry was performed using a three-dimensional workstation to measure three pelvic angles and both transverse and sagittal diameters of the lesser pelvis at four distinct levels: the inlet, two mid- cavity axial planes, and the outlet.The study found that

age-related changes were most pronounced at the pelvic inlet and outlet, while the mid-cavity experienced less change. Notably, the transverse diameter between acetabular centers and the sagittal diameter at the ischial spines were unaffected by age. Generally, pelvic parameter changes with age were similar for both sexes, with one exception: the proportion of diameters at the ischial spines decreased significantly in males only. These changes align with trends observed in pelvic floor diseases, suggesting a shift towards pathological changes with aging.

18. **A Study review by DeSilva etc. all, accepted on 14 January2017**, the pelvis served as a pivotal element in both bipedal locomotion and childbirth, reflecting its evolutionary adaptations and functional demands. DeSilva and Rosenberg highlighted the pelvis's complex interplay between its structural form and functional roles. Notably, the pelvis exhibited considerable sexual dimorphism, a trait that had profound implications for obstetric outcomes. The human pelvis was uniquely adapted to bipedalism; it was characterized by a shorter, broader shape compared to that of our ape relatives, which facilitated efficient upright walking. This adaptation was essential for understanding the evolutionary pressures that shaped the pelvis. The review emphasized that the human pelvis's dimensions and morphology, particularly in females, were intricately linked to both bipedal locomotion and reproductive needs. This dual functionality underscored the evolutionary trade-offs and adaptations that occurred over time. DeSilva and Rosenberg's work synthesized findings from thirteen original research papers, providing a rich understanding of pelvic anatomy, development, and variation.The collection of studies presented advanced knowledge of the pelvis while raising new questions about its evolution and function. This body of work offered valuable insights for both current and future research, suggesting that the pelvis remained a crucial area of study for understanding human evolution and physiology.

19. **A Study K.Sharma etc. all, on August 2016.,**This research delved into the ontogenic patterns of pelvic growth during adolescence, variations in pelvic dimensions, and continued growth into the twenties and thirties. The study also examined structural remodeling related to childbirth and the relationship between pelvis area and physique. Previous literature highlighted several key points in this context. Peak growth velocity for skeletal traits typically occurred between ages 11 and 12, prior to the average menarche age of 13.5 years. However, peak growth for body weight and BMI followed menarche, occurring between ages 14 and 15. The critical pelvic width hypothesis, which posited a necessary 240 mm iliocristale width for menarche, was found to be only a statistical association, not a causal factor.Further literature indicated that malnutrition prevalence was higher during puberty due to increased nutritional demands.

For adults, BMI was weakly correlated with stature but strongly linked with body breadths, indices, and weight. Research showed that body mass and pelvis size continued to change into the early 30s, with pelvic remodeling occurring post-first childbirth, suggesting phenotypic plasticity. Pelvis area was significantly associated with stature, BMI, and age. Stepwise multiple regression analysis underscored BMI as the primary determinant of pelvis area, with stature and age also playing contributory roles. This comprehensive examination of pelvic growth patterns and their implications was vital for understanding the complex interplay of developmental and environmental factors on pelvic morphology.

20. **A Study by Enas M.A. Mostafaetc. all, posted on 15 june, 2016.,,** the sex identification of unknown human skeletal remains was evaluated with a focus on the pelvis, a known reliable indicator due to its sexual dimorphism. The aim was to create a logistic regression formula fordetermining sex using three-dimensional computed tomography (3D-CT) of the pelvis and to test its validity for the Egyptian population in the Suez Canal region. The study involved 141 pelvic-abdominal CT images, all free of pelvic orthopedic disorders. These images were reconstructed into 3D-CT pelvic images and divided into a calibration group (47 males and 47females) and a test group with unknown sex (47 images). Twenty radiometric variables were measured for the calibration group, and a logit response formula was developed for sex prediction. When applied to the test group, the formula demonstrated perfect sensitivity, specificity, and overall accuracy of 100%. This method proved to be a quick and reliable technique for establishing sex from CT images of the pelvis bone, highlighting its potential as a valuable tool in forensic and anthropological applications.

21. **A systematic review study by Laura Tobias Gruss etc all., on 5 March 2015.,** The fossil record of the human pelvis revealed key evolutionary changes driven by selective pressures related to locomotion, childbirth, and thermoregulation, often conflicting with one another. Early hominins experienced significant pelvic modifications compared to non-human primates, which facilitated bipedalism. Over time, further changes led to the development of a wide pelvis with a **platypelloid** birth canal. This pelvic form persisted for 3–4 million years with only moderate adjustments in response to environmental shifts, locomotor behavior, and brain size increase. It wasn't until *Homo sapiens* emerged around 200,000 years ago that a narrower, anatomically modern pelvis with a circular birth canal appeared. This shift seemed to reflect the need to accommodate larger neonatal brains and a narrow body adapted for thermoregulation in warm climates. The modern birth canal's shape and alignment, requiring fetal rotation, allowed early *Homo sapiens* to balance encephalization and obstetric needs with a body form suited for efficient locomotion and heat dissipation.

22. **A research by D Franklin etc all ., on 02 may 2014.,** Previous forensic research emphasized the importance of developing accurate biological profiles, including sex estimation, in routine casework involving unidentified skeletal remains. The choice ofmethod for sex estimation had been closely tied to the preservation of skeletal remains, particularly the availability of key bones such as the pelvis. Earlier studies stressed that the applied methods needed to provide statistically quantified accuracy rates and predictive confidence to meet legal evidentiary standards. To achieve this, the application of population-specific standards was considered essential.Studies focusing on skeletal pelvic dimorphism demonstrated that the pelvis, being one of themost sexually dimorphic bones, was frequently used to estimate sex with high accuracy. In particular, research on contemporary Western Australian individuals provided insights into the reliability of pelvic measurements for sex estimation. Researchers had utilized multi-slice computer tomography (MSCT) scans of pelves from both male and female adults to examine the extent of sexual dimorphism in this population. Following 3D rendering, landmarks on the pelvis were identified, and a series of linear measurements and angles were calculated. These measurements were then analyzed using discriminant function analyses, which had been validated through jackknife procedures to ensure robust classification results.Previous studies had found that nearly all pelvic measurements showed significant sexual dimorphism, with sex differences accounting for up to 65% of the variance within the sample. The transverse pelvic outlet and the subpubic angle were identified as the most significant contributors to sex discrimination, yielding accuracy rates as high as 100% when the complete pelvis was used (based on 10 variables). In cases where fewer variables were available, such as the ischial length alone, the accuracy rate dropped to 81.2%, though it remained relatively high.The research also highlighted that sex estimation accuracy was maximized when the entire pelvis was preserved, underscoring the importance of using comprehensive morphometric data. This study represented the first forensic investigation into pelvic sexual dimorphism in a Western Australian population, and its findings demonstrated that pelvic measurements could be used with a high degree of accuracy for sex classification. As a result, these methods were considered valuable in forensic anthropology for providing reliable, population- specific standards for sex estimation based on skeletal remains.

23. **A study by Hitoshi Biwasaka etc. all ., on 10 June 2012.,** Previous studies on pelvic morphology employed three-dimensional (3D) imaging reconstructed from multi-slicecomputed tomography (CT) data to analyze sexual dimorphism. Researchers had focused on contemporary populations, such as the Japanese, where male and female pelvic structures were examined in detail. Curvature analysis was commonly used to assess

specific anatomical regions, including the great sciatic notch (GSN), the pubic arch, and the greater pelvis, to identify differences between sexes.Earlier research demonstrated that 3D reconstructions of pelvic CT images provided clear visualizations of anatomical landmarks, facilitating accurate measurements. Studies had shown that the curvature radii of the best-fit circles along the edges of the GSN and pubic arch could be used effectively to distinguish between male and female pelves. Accuracy rates for sex classification based on these measurements were notably high, with 89.1% of cases correctly identified from the GSN and 94.7% from the pubic arch, when appropriate cut-off values were applied. This method proved reliable even in regions of the GSN that were resistant to postmortem damage, makingit useful for forensic applications.Curvature analysis of the greater pelvis, however, revealed no significant differences between sexes in some areas. For instance, curvature radii of the best-fit spheres for the greater pelvis showed no sex-related distinctions. In contrast, a pronounced difference was observed in the left iliac fossa of males, where the curvature was significantly larger than that of the right iliac fossa.This 3D laterality, particularly in males, had not been as prominent in earlier 2D studies, marking an important discovery in the field. In females, no significant laterality was observed, further underscoring the potential of using 3D curvature analysis as an index of sexual dimorphism.Previous findings also highlighted the importance of using 3D techniques to capture more detailed and accurate measurements of the pelvis. While left-sided dominance had been noted in 2D pelvic measurements, the greater significance of this asymmetry in males when using 3D data added a new dimension to the understanding of pelvic sexual dimorphism. Overall, the application of 3D imaging and curvature analysis offered more precise tools for distinguishing between male and female skeletal remains, contributing valuable data for both anthropological and forensic research.

24. **A research by SJ Decker, etc. all, on 19 may 2011.,** Previous studies consistently highlighted the adult os coxae and sacrum as primary skeletal elements for sex estimation. Traditional methods of sex estimation from these bones had relied heavily on visual assessment of morphological traits. However, advancements in medical imaging, particularly computed tomography (CT), enabled researchers to generate three-dimensional (3D) models of the skeleton from clinical scans of known individuals, offering a new approach to skeletal analysis. Earlier research indicated that CT-based imaging provided a valuable opportunity to assess skeletal traits in situ, allowing for more precise and reproducible measurements. Researchers had used abdominopelvic CT-derived models in prior studies to explore simple and repeatable metric methods for estimating sex. These methods often incorporated both obstetric measurements—traditionally important for understanding pelvic morphology—and nonmetric traits originally derived

from the Phenice method. Studies consistently demonstrated that combining these metric and nonmetric approaches improved the reliability of sex estimation from pelvic bones.One notable contribution from past research was the development of a four- variable discriminant function for sex estimation, which was based on statistical analyses of pelvic traits. This model achieved an exceptionally high cross-validated accuracy rate of 100%, underscoring the robustness of the method. Furthermore, inter-observer error was minimal, averaging only 2.2%, which indicated that the measurements were highly repeatable and consistent across different evaluators.Comparative analyses, such as those using FORDISC 3.0, had also been employed in previous studies to validate these findings and compare them with existing sex estimation standards. The consensus from earlier research was that while traditional methods of sex determination from the pelvis had been reliable, the integration of more in vivo data from CT scans significantly enhanced accuracy. These studies called for updates to current sex determination standards to incorporate CT-derived data, as it provided a more precise and quantifiable approach to pelvic analysis.In summary, prior literature consistently demonstrated the efficacy of using CT-based imaging and metric methods for sex estimation from the pelvis. These advancements offered forensic and anthropological researchers a more accurate and reliable tool for identifying sex, with particular emphasis on the need to modernize existing standards by including in vivo data from medical imaging.

25. **A study by Pavel Müller etc. all, 2011.,** The review delves into the capabilities and applications of Computed Tomography (CT) in industrial contexts, emphasizing its precision in inspecting both external and internal structures. The chapter first elucidates the fundamental principles of CT, highlighting the distinctions between medical and industrial CT scanners. Various CT systems are classified, and the chapter explores CT's diverse industrial applications, including its role in coordinate metrology. The advantages and disadvantages of CT usage are also discussed. CT systems comprise an X-ray source, a rotary table, an X-ray detector, and a data processing unit for analyzing and visualizing measurement results. CT generates cross-sectional images by emitting photon beams through an object from various angles during a complete revolution. This process, known as attenuation, involves X-rays being absorbed, scattered, or transmitted. The detected photons are reconstructed into 3D images representing the object's electron density distribution. The chapter outlines a process chain for obtaining measurement results, starting with object scanning and parameter setting. Following this, 2D projections are reconstructed into a 3D voxel matrix, with each voxel representing local X-ray absorption density. Correct threshold determination is crucial for

accurate image segmentation and surface data generation, which can then be used for dimensional measurements such as wall thickness analysis and geometrical comparisons.

26. **The study by Kobi Stav etc. all., on July 2007.,** aimed to examine the anatomical features of the pelvic bones and muscles in women with urinary incontinence (UI). Conducted between October 2005 and January 2006, the study involved 212 consecutive women who underwent pelvic computerized tomography at our center. Prior to the examination, all participants completed a clinical and demographic questionnaire, which included detailed questions about UI. The study assessed various anatomical parameters using multiplanar reformation and three-dimensional techniques. Specifically, the research focused on different bony parameters, pelvic floor muscle angles, densities, and cross-sectional areas. Of the participants, 93 women (46.5%) had UI, while the remaining served as the control group. A logistic regression model was used to identify risk factors for UI. Results indicated that women with UI were generally older (mean age of 60.97 years compared to 50.77 years in the control group) and had a higher body mass index. Additionally, they had undergone more previous hysterectomies, pelvic irradiation, and had higher incidences of diabetes mellitus. Key risk factors for UI included the patient's age and previous hysterectomy. Anatomical parameters such as pelvic-inlet diameter, pelvic-inlet anterior-posterior diameter, pelvic-outlet diameter, and transverse perineal muscle cross-section diameter were also significant risk factors. The study concluded that pelvic inlet and outlet dimensions are major risk factors for developing UI in women. These findings contribute to a better understanding of the pathophysiology of UI and may inform future therapeutic approaches.

27. **A systematic review study by Goldman etc. all, Sep 2007.,** In the realm of paleopathology and anthropology, the utilization of diagnostic imaging has been transformative since its clinical inception. The discipline of paleoimaging has capitalized on various diagnostic techniques, yet Cone Beam Computed Tomography (CBCT) remains underutilized comparedto MultiSlice Computed Tomography (MSCT). This study aimed to explore the potential benefits CBCT could bring to paleoimaging. CBCT's characteristics and applications were examined across clinical, forensic, legal medicine, and paleopathological contexts. A comparative analysis of an ancient mandible using both CBCT and MSCT was conducted to assess image quality, specifically spatial resolution. The results demonstrated that CBCT produces high-quality images of mineralized tissues and can effectively image metallic artifacts, indicating its suitability for examining bony remains and archaeological artifacts. The findings suggest that

CBCT holds significant promise as a viable imaging technique for ancient bone studies, advocating for its increased adoption in paleoimaging. Although CBCT's application in bioarchaeological research remains nascent, further exploration is warranted. The study encourages the broader use of CBCT in archaeological sample analysis to fully realize its potential in the field.

28. **A systematic review study by Lazarevski etc. all, Mar 2004.,** The study conducted radiopelvimetric investigations on colpocystographies in the I position, analyzing 476 patients, including 392 cases of genital prolapses and 84 control cases, from April 1, 1968, to February 28, 1973. An original measurement, distance "X", was introduced to characterize the anterior compartment of the pelvis, which is directly influenced by intra-abdominal force. Thefindings indicated that prolapse cases exhibited horizontalization and an infundibular caudal enlargement of the pelvic bone system. Specifically, total uterine prolapses showed a 6.7% larger middle pelvis, a 13.8% larger pelvic outlet, and a 56.7% longer distance "X". The pelvic inlet was more horizontal by 9.8° compared to control cases. These changes were attributed to sacral nutation, dorsal transposition, and antero-posterior rotation around the acetabulum. The study also noted that aging exacerbated these changes, with significant differences observed in patients over 61 years old. In contrast, control cases maintained a youthful pelvic form irrespective of age. The study suggested that pelvic bone changes due to aging and overloading might influence genital prolapse development. Additionally, it was found that the pelvic diaphragm's resistance was three times lower in total uterine prolapses, and the force on the ventral pelvic compartment in older patients was three times greater. Thisbiomechanical approach provided new insights into the pathogenesis of genital prolapse, aiding in its prevention and treatment.

29. **A Research by Eddie H.M Sze MD etc. all, published on February 1999.,** The literature review aimed to compare bony pelvis dimensions between white women with and without genital prolapse using computed tomography (CT) pelvimetry. Thirty-four multiparous whitewomen with vaginal prolapse beyond the hymen and 34 matched controls without pelvic support defects underwent CT pelvimetry. The study measured the anteroposterior and transverse diameters of the pelvic inlet, the interspinous diameter of the midpelvis, and the intertuberous diameter of the pelvic outlet. A post hoc power analysis indicated that 22 women per group were necessary to detect a 10% difference in pelvic dimensions with a 90%power. Results showed that the mean age of subjects was 63.4 ± 8.3 years, compared to 62.9 ± 7.8 years for controls. Mean parity was 3.3 ± 1.7 for subjects and 3.6 ± 1.7 for controls. Theanteroposterior, interspinous, and intertuberous diameters did not differ significantly between groups.

However, the transverse diameter of the pelvic inlet was significantly greater in women with prolapse (12.9 ± 0.7 cm) than in those without prolapse (12.4 ± 0.6 cm, P =.006). The study concluded that women with advanced vaginal prolapse had larger transverse inlet diameters compared to those with normal pelvic support. This finding suggests a potential anatomical difference in the bony pelvis related to prolapse. No English-language articles addressing the correlation between bony pelvis dimensions and genital prolapse were found in a MEDLINE search for relevant literature from 1966 to 1998.

30. **A systematic review study by Robert G. Tague etc. all,September 1989 ,** "Variation in Pelvic Size Between Males and Females" by Robert G. Tague examined sexual dimorphism in pelvic morphology. Previous research had suggested that females exhibited less variability in pelvic dimensions due to conflicting selection pressures for locomotion efficiency and obstetric adequacy. This hypothesis, supported by Meindl et al. (1985) through observational methods, was re-evaluated byTague using metrical analysis. Tague's findings indicated no significant sexual differences in pelvic variability, contrasting Meindl's conclusions. The study utilized skeletal samples from the Hamann-Todd collection and various Amerindian populations, employing both visual assessments and metrical data. Results demonstrated that while visual sexing methods revealed more variability in male pelves, the actual dimensions of the true pelvis were equally variable in both sexes. This challenged the notion that female pelvic morphology was more canalized due to reproductive demands. Tague's research contributed to the understanding of pelvic morphology by highlighting the complexity of selection pressures and the need for diverse methodological approaches in studying sexual dimorphism.

Chapter 4

Material and Methodology

Study Design: - Hospital Based Observational study

Sample Size: - 114

Place Of Study: - Santosh University

Time Period: - 6-month Instruments –

*** Criteria for sampling:**

Inclusion criteria: -

Age between – 10 to 65 years Whole Abdomen, KUB Abdomen Pain

Abdominal inflammatory

Exclusion criteria: -

Patients who have serious medical condition. Dislocation or Subluxation of Hip joint.

Bones' fractures.

Transitional vertebras.

Polytrauma.

Chapter 5
HYPOTHESIS

Null Hypothesis (H0): There are no significant age-related changes in the width of the female pelvis, as measured by the distances from the Anterior Superior Iliac Spine (ASIS) to the Right and Left Sacroiliac (SI) joints and the overall ASIS-to-ASIS distance.

Alternative Hypothesis (H1): There are significant age-related changes in the width of the female pelvis, as measured by the distances from the Anterior Superior Iliac Spine (ASIS) to the Right and Left Sacroiliac (SI) joints and the overall ASIS-to-ASIS distance.

Explanation of the Hypotheses in the Context of the Results:

To investigate these hypotheses, the study utilized a hospital-based observational design with a sample size of 114 female subjects aged 10 to 65 years. The methodology involved abdominal or pelvic examinations performed by a scanner, with CT pelvimetry on pelvic images in coronal and sagittal views. Statistical analysis was performed using multiple linear regression to explore the relationship between age and pelvic measurements.

Key Findings:

- The mean distances from ASIS to Right SI and ASIS to Left SI were 83.96 mm and 84.77 mm, respectively, with a mean overall ASIS-to-ASIS distance of 220.33 mm.
- Pearson correlation analysis indicated a strong positive correlation between ASIS to Right SI and ASIS to Left SI ($r = 0.906$, $p < 0.01$).
- Age showed a weak to moderate positive correlation with ASIS to Left SI ($r = 0.272$, $p < 0.01$), suggesting a slight increase in this measurement with age.
- Age had weaker, non-significant correlations with ASIS to Right SI ($r = 0.176$) and overall, ASIS-to-ASIS distance ($r = 0.141$).

"The study aimed to assess age-related changes in the width of the female pelvis. To achieve this, the following hypotheses were formulated:

- **Null Hypothesis (H0):** There are no significant age-related changes in the

width of the female pelvis.

- **Alternative Hypothesis (H1):** There are significant age-related changes in the width of the female pelvis.

Our findings indicated a significant, albeit weak to moderate, positive correlation between age and the ASIS to Left SI distance, while the ASIS to Right SI distance and the overall ASIS-to-ASIS width did not show significant correlations with age. Thus, the null hypothesis (H0) was partially rejected, supporting the alternative hypothesis (H1) for the ASIS to Left SI distance. These results contribute to our understanding of how the female pelvis changes with age and have implications for clinical practice and anthropological research."

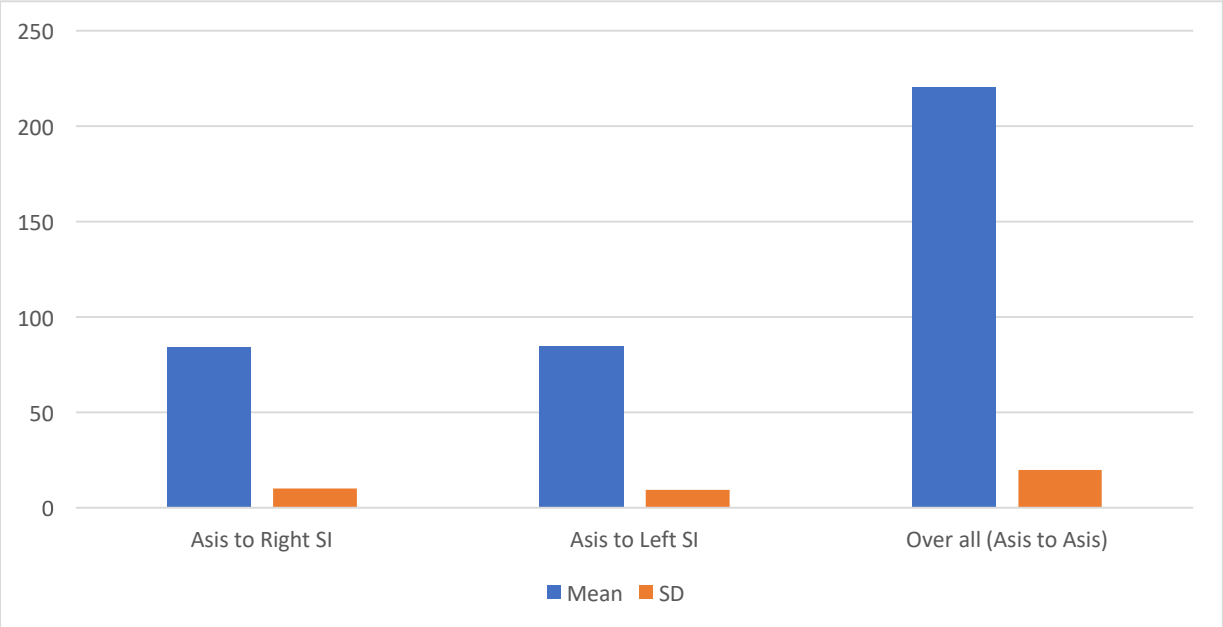
Chapter 6

Results

114 patients were taken for the measurements. The median age was 36.50years (IQR = 21years).

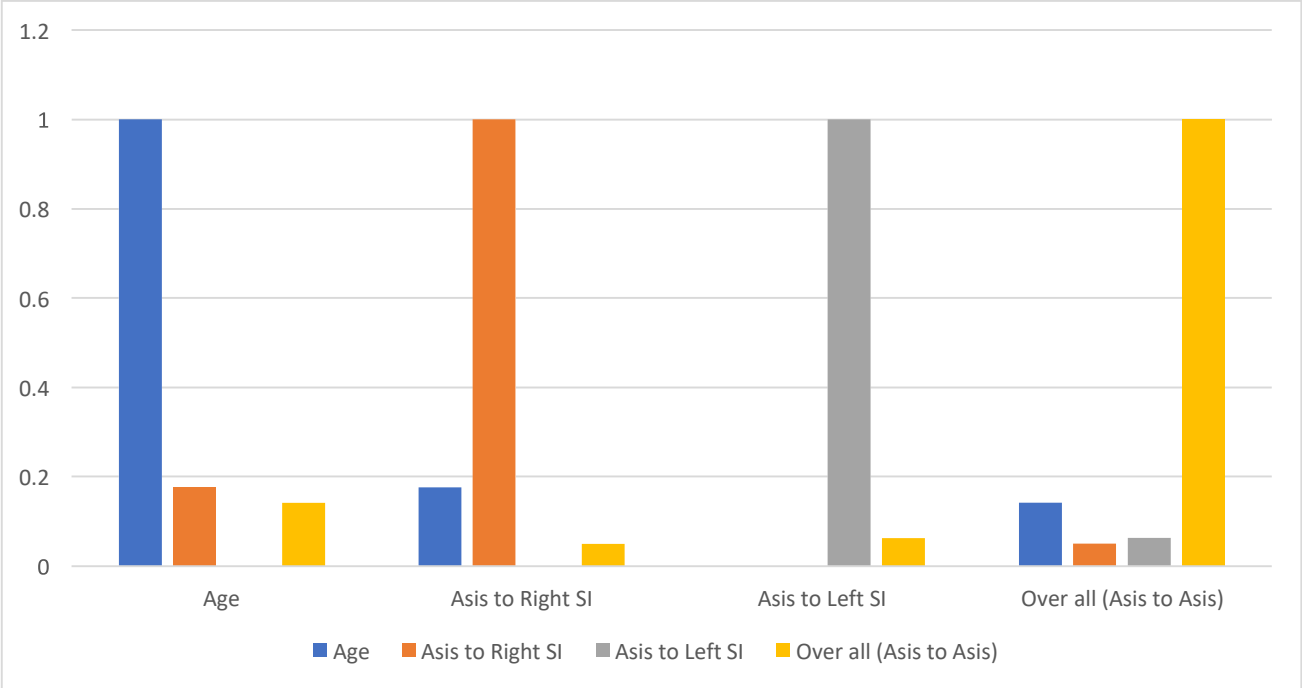
PARAMETER	Mean	SD
Asis to Right SI	83.96	10.10
Asis to Left SI	84.77	9.48
Over all (Asis to Asis)	220.33	19.62

The mean distance from the Anterior Superior Iliac Spine (ASIS) to the right Sacroiliac (SI) joint is 83.96 millimeters, with a standard deviation of 10.10 mm. For the left side, the mean ASIS to SI joint distance is slightly larger at 84.77 mm, with a standard deviation of 9.48 mm. The overall measurement from ASIS to ASIS, spanning the width of the pelvis, has a mean of 220.33 mm and a standard deviation of 19.62 mm.



Pearson Correlation	Age	Asis to Right SI	Asis to Left SI	Over all (Asis to Asis)
Age	1	.176	.272**	.141
Asis to Right SI	.176	1	.906**	.050
Asis to Left SI	.272**	.906**	1	.062
Over all (Asis to Asis)	.141	.050	.062	1
**Correlation is significant at the 0.01 level (2-tailed)				

There is a strong, positive correlation between Asis to Right SI and Asis to Left SI ($r = 0.906$, $p < 0.01$), indicating a very high degree of association between these two measurements. Age shows a weak to moderate positive correlation with Asis to Left SI ($r = 0.272$, $p < 0.01$), suggesting a slight tendency for this measurement to increase with age. However, Age has weaker, non-significant positive correlations with Asis to Right SI ($r = 0.176$) and Overall (Asis to Asis) ($r = 0.141$). The Overall (Asis to Asis) measurement shows very weak, non-significant correlations with all other variables (r ranging from 0.050 to 0.141).



DISCUSSION

The primary aim of this study was to assess age-related changes in the width of the female pelvis. Understanding how pelvic dimensions change with age can provide insights into the aging process, offer clinical relevance for the management of pelvic-related conditions, and contribute to anthropological knowledge about human adaptation and population health.

The study involved a sample of 114 female subjects aged between 10 and 65 years, undergoing abdominal or pelvic examinations using CT pelvimetry. Measurements were taken from the Anterior Superior Iliac Spine (ASIS) to the Right and Left Sacroiliac (SI) joints, as well as the overall ASIS-to- ASIS distance. Statistical analysis was performed using multiple linear regression and Pearson correlation to explore the relationship between age and these pelvic measurements.

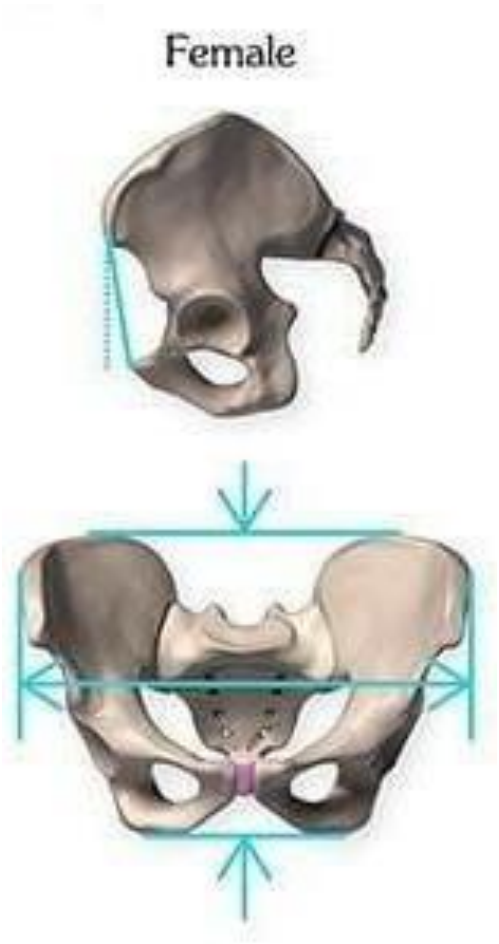


Fig.6 Female Pelvis

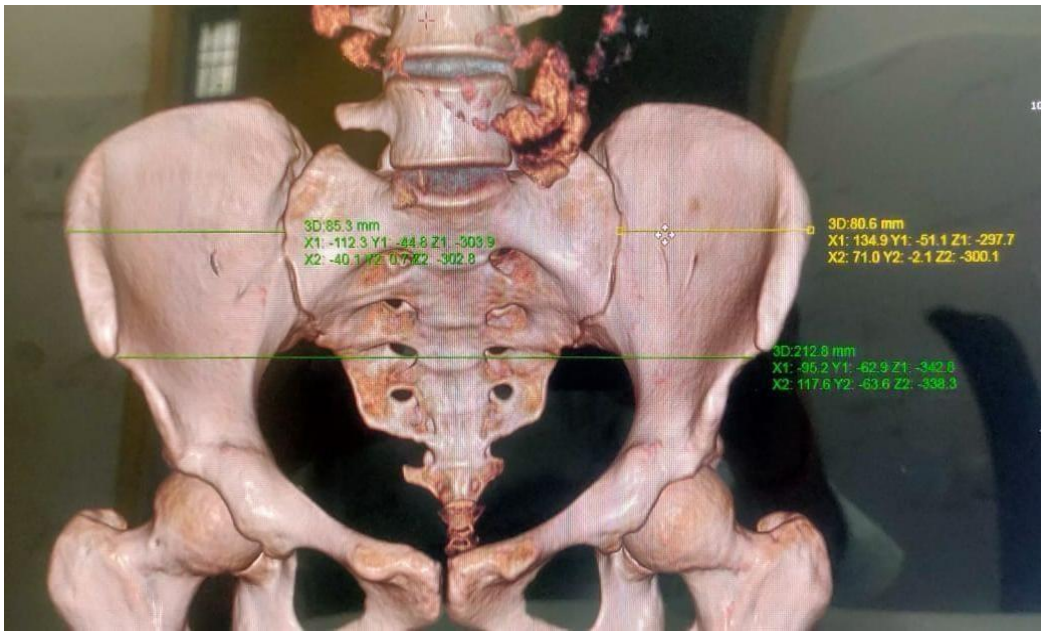
The results revealed that the mean distance from ASIS to Right SI was 83.96 mm, with a standard deviation of 10.10 mm, while the mean distance from ASIS to Left SI was 84.77 mm, with a standard deviation of 9.48 mm. The overall ASIS-to-ASIS distance had a mean of 220.33 mm and a standard deviation of 19.62 mm.

Pearson correlation analysis showed a strong, positive correlation between ASIS to Right SI and ASIS to Left SI ($r = 0.906$, $p < 0.01$), indicating a very high degree of association between these two measurements. This suggests that as one side of the pelvis widens, the other side tends to widen proportionally, reflecting symmetrical growth or changes in pelvic dimensions

Age exhibited a weak to moderate positive correlation with ASIS to Left SI ($r = 0.272$, $p < 0.01$), suggesting that this measurement tends to increase slightly with age. This finding supports the notion

that certain pelvic dimensions may change as women age, potentially due to factors such as hormonal changes, childbirth, and overall skeletal maturation and aging. However, age had weaker, non- significant correlations with ASIS to Right SI ($r = 0.176$) and the overall ASIS-to-ASIS distance ($r = 0.141$). This indicates that not all pelvic dimensions are equally affected by aging, and the changes may be more specific to certain aspects of the pelvic structure.

The weak correlations between age and the overall ASIS-to-ASIS width, as well as the ASIS to Right SI distance, suggest that these dimensions do not significantly change with age. This finding is particularly relevant for clinical practice, as it implies that certain pelvic measurements remain relatively stable over a woman's lifespan, which can be useful in diagnosing and managing pelvic-related conditions without considering significant age-related variations.



In the context of anthropological insights, examining age-related variations in pelvic width can provide valuable information about evolutionary biology and human adaptation. The observed changes in the ASIS to Left SI distance with age may reflect adaptive mechanisms related to reproductive health, as the pelvis plays a critical role in childbirth. Understanding these changes can contribute to a broader knowledge of human skeletal development and adaptation.

The study aimed to assess age-related changes in the width of the female pelvis, providing insights into the aging process, clinical relevance for pelvic-related conditions, and anthropological knowledge about human adaptation and population health. The results revealed several important findings that warrant further discussion.

Symmetry in Pelvic Growth

One of the most striking observations was the strong, positive correlation between the ASIS to Right SI and ASIS to Left SI measurements ($r = 0.906$, $p < 0.01$). This high degree of association indicated that as one side of the pelvis widened, the other side tended to widen proportionally. This symmetrical growth pattern suggested a coordinated developmental process in the female pelvis, potentially driven by genetic factors, hormonal influences, or biomechanical requirements. The symmetry in pelvic growth could have important implications for obstetric outcomes and overall pelvic stability.

Age-Related Changes

The study found a weak to moderate positive correlation between age and the ASIS to Left SI measurement ($r = 0.272$, $p < 0.01$). This suggested that this particular pelvic dimension tended to increase slightly with age. Several factors could have contributed to this observation:

1. Hormonal changes: The cumulative effects of hormonal fluctuations throughout a woman's life, including those related to puberty, pregnancy, and menopause, might have influenced pelvic bone remodeling.
2. Childbirth: For women who had given birth, the process of pregnancy and delivery could have led to subtle changes in pelvic dimensions over time.
3. Skeletal maturation and aging: The natural processes of bone growth, remodeling, and age-related changes in bone density might have contributed to alterations in pelvic width.

However, it was noteworthy that age had weaker, non-significant correlations with ASIS to Right SI ($r = 0.176$) and the overall ASIS-to-ASIS distance ($r = 0.141$). This differential effect of age on various pelvic measurements highlighted the complexity of pelvic development and aging. It suggested that not all aspects of the pelvic structure were equally affected by the aging process,

which could have important implications for both clinical practice and anthropological understanding.

Clinical Implications

The weak correlations between age and the overall ASIS-to-ASIS width, as well as the ASIS to Right SI distance, indicated that these dimensions remained relatively stable over a woman's lifespan. This finding had significant clinical relevance:

1. Diagnostic consistency: The stability of certain pelvic measurements across age groups suggested that these dimensions could serve as reliable reference points for diagnosing pelvic abnormalities, regardless of a patient's age.
2. Treatment planning: Understanding which pelvic dimensions were more likely to change with age and which remained stable could inform treatment strategies for pelvic floor disorders, orthopedic conditions, or obstetric care.
3. Imaging protocols: The findings could influence the development of age-specific imaging protocols or the interpretation of pelvic imaging results, taking into account the expected variations (or lack thereof) in certain measurements.

Anthropological Insights

From an anthropological perspective, the study provided valuable data on the patterns of pelvic development and aging in women:

1. Evolutionary adaptations: The observed changes (or lack thereof) in pelvic dimensions with age might have reflected evolutionary adaptations related to bipedalism, childbirth, or other selective pressures on human pelvic morphology.
2. Population health indicators: Variations in pelvic dimensions across age groups could serve as indicators of population health, reflecting factors such as nutrition, physical activity patterns, or environmental influences on skeletal development.
3. Comparative studies: The data from this study could form a basis for comparative analyses with other populations or prehistoric samples, contributing to our understanding of human variation and adaptation over time.

Limitations and Future Directions

While the study provided valuable insights, it also had limitations that could be addressed in future research:

1. Sample size and diversity: A larger and more diverse sample size could improve the generalizability of the findings and allow for more nuanced analyses of age-related changes.
2. Longitudinal design: A longitudinal study design, following the same individuals over time, could provide more definitive evidence of age-related changes in pelvic dimensions.
3. Additional measurements: Including more pelvic measurements and considering three-dimensional analyses could offer a more comprehensive understanding of pelvic morphology changes.
4. Contextual factors: Future studies could explore the influence of factors such as body mass index, physical activity levels, parity, and hormonal status on age-related changes in pelvic dimensions.

CONCLUSION

In conclusion, this study provides important insights into the age-related changes in female pelvic dimensions. The findings indicate that while certain pelvic measurements, such as the ASIS to Left SI distance, show a slight increase with age, other measurements, including the overall ASIS-to-ASIS width and ASIS to Right SI distance, remain relatively stable. These results have significant implications for clinical practice, as they highlight the importance of considering specific pelvic dimensions when diagnosing and managing pelvic-related conditions in women. Additionally, the study contributes to our understanding of the aging process and human skeletal adaptation, offering valuable information for both clinical and anthropological research. Further studies with larger sample sizes and diverse populations are recommended to expand upon these findings and provide a more comprehensive understanding of age-related pelvic changes.

BIBLIOGRAPHY

1. Kolesova, Oksana, Aleksandrs Kolesovs, and Janis Vetra. "Age-related trends of lesser pelvic architecture in females and males: a computed tomography pelvimetry study." Anatomy & Cell Biology 50.4 (2017): 265-274.
2. DeSilva, Jeremy M., and Karen R. Rosenberg. "Anatomy, development, and function of the human pelvis." The Anatomical Record 300.4 (2017): 628-632.
3. Mahadevan, Vishy. "Anatomy of the pelvis." Surgery (Oxford) 36.7 (2018): 333-338.
4. Tague, Robert G. "Variation in pelvic size between males and females." American Journal of Physical Anthropology 80.1 (1989): 59-71.
5. Sharma, Krishan, Puneet Gupta, and Shailza Shandilya. "Age related changes in pelvis size among adolescent and adult females with reference to parturition from Naraingarh, Haryana (India)." Homo 67.4 (2016): 273-293.
6. Waltenberger, Lukas, Katharina Rebay-Salisbury, and Philipp Mitteroecker. "Age dependent changes in pelvic shape during adulthood." Anthropologischer Anzeiger 79.2 (2022).
7. Novak, Jan M., et al. "The relationship between adolescent obesity and pelvis dimensions in adulthood: a retrospective longitudinal study." PeerJ 8 (2020): e8951.
8. Setiawati, Rosy, et al. "Anthropometric study using three-dimensional pelvic CT scan in sex determination among adult Indonesian population." Forensic Science, Medicine and Pathology 19.1 (2023): 24-33.
9. Telfer, Scott, et al. "The effect of age and sex on pelvic bone density measured opportunistically in clinical CT scans." Journal of Orthopaedic Research® 39.3 (2021): 485-492.
10. Inagaki, Naoya, et al. "Distribution of hounsfield unit values in the pelvic bones: A comparison between young men and women with traumatic fractures and older men and women with fragility fractures: A retrospective cohort study." BMC Musculoskeletal Disorders 23.1 (2022): 305.
11. Setiawati, Rosy, Ika Ruriana, and Giuseppe Guglielmi. "Anthropometry Study Using Adult Pelvic 3D CT for Determining Sexes at Dr.Soetomo General Hospital, Indonesia." (2021).
12. Mostafa, Enas, et al. "Adult sex identification using three-dimensional computed tomography (3D-CT) of the pelvis: a study among a sample of the Egyptian population." Arab Journal of Forensic Sciences and Forensic Medicine 10 (2016):0026460.

13. Stav, Kobi, et al. "Pelvis architecture and urinary incontinence in women." Europeanurology 52.1 (2007): 239-244.
14. Sze, Eddie HM, et al. "Computed tomography comparison of bony pelvis dimensions between women with and without genital prolapse." Obstetrics & Gynecology 93.2 (1999): 229-232.
15. Lazarevski, Momčilo B. "Pelvic bone system changes and pathogenesis of genital prolapse–a radiopelvimetric study." Gynaecologia et perinatologia: journal for gynaecology, perinatology, reproductive medicine and ultrasonic diagnostics 13.1 (2004): 1-12.
16. Auerbach, Benjamin M., et al. "Variation in obstetric dimensions of the human bony pelvis in relation to age-at-death and latitude." American journal of physical anthropology 167.3 (2018): 628-643.
17. Cantatore, Angela, and Pavel Müller. "Introduction to computed tomography." (2011).
18. Goldman, Lee W. "Principles of CT and CT technology." Journal of nuclear medicinetechnology 35.3 (2007): 115-128.
19. Valdino, Yosafat, Johannes A. Pradana, and Niken T. Listyorini. "Evolution and recent progress of Computed Tomography Scan (CT-Scan)."
20. Mahadevan, Vishy. "Anatomy of the pelvis." Surgery (Oxford) 36.7 (2018): 333-338.
21. Wobser, Anna M., Zachary Adkins, and Randy W. Wobser. "Anatomy, abdomen and pelvis,bones (ilium, ischium, and pubis)." (2018).
22. Figueroa, Christian, Felix Jozsa, and Patrick H. Le. "Anatomy, Bony Pelvis and Lower Limb,Pelvis Bones." (2019).
23. Ahrend, Marc-Daniel, et al. "Development of generic Asian pelvic bone models using CT-based 3D statistical modelling." Journal of orthopaedic translation 20 (2020): 100-106.
24. Gruss, Laura Tobias, and Daniel Schmitt. "The evolution of the human pelvis: changing adaptations to bipedalism, obstetrics and

thermoregulation." *Philosophical Transactions of the Royal Society B: Biological Sciences* 370.1663 (2015): 20140063.

25. Ruriana, Ika, and Rosy Setiawati. "Sex identification using adult pelvic 3D CT scan: an anthropometric study." *Sex Identification Using Adult Pelvic 3D CT Scan: An Anthropometric Study* 64.1 (2020): 6-6.
26. Torimitsu, Suguru, et al. "Population affinity estimation using pelvic measurements based oncomputed tomographic data acquired from Japanese and Western Australian populations." *International Journal of Legal Medicine* (2024): 1-10.
27. Biwasaka, Hitoshi, et al. "Analyses of sexual dimorphism of reconstructed pelvic computed tomography images of contemporary Japanese using curvature of the greater sciatic notch, pubic arch and greater pelvis." *Forensic science international* 219.1-3 (2012): 288-e1.
28. Franklin, Daniel, et al. "Morphometric analysis of pelvic sexual dimorphism in a contemporary Western Australian population." *International journal of legal medicine* 128(2014): 861-872.
29. Decker, Summer J., et al. "Virtual determination of sex: metric and nonmetric traits of the adult pelvis from 3D computed tomography models." *Journal of forensic sciences* 56.5 (2011): 1107-1114.
30. Johnstone-Belford, Eden, Ambika Flavel, and Daniel Franklin. "Morphoscopic observations in clinical pelvic MDCT scans: assessing the accuracy of the Phenice traits for sex estimationin a Western Australian population." *Journal of Forensic Radiology and Imaging* 12 (2018): 5-10.

ANNEXURES

SANTOSH
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F. No. SU/R/2024/1344[52] Dated: 17.05.2024

Subject: Grant of Ethical Clearance for **Dissertation Protocol** Topic **"Assessment of Age Related Changes in Width of Female Pelvis",** submitted by **SUMIT SINGH,** student of M.Sc Medical Imaging Technology, 2022 Batch.

*****

With reference to the request for grant of Ethical Clearance for the Dissertation Protocol entitled **"Assessment of Age Related Changes in Width of Female Pelvis", SUMIT SINGH** is informed that the **Dissertation Protocol** submitted by him/her was considered by the **Screening Committee** of the **Allied Health Sciences** in its meetings held on 07.02.2024 and 29.02.2024. The recommendations of the **Screening Committee** were considered in detail by the **Institutional Ethics Committee** in its meeting held on **15.05.2024** and the same was **approved** by the **Ethics Committee** of the **Santosh Deemed to be University, Ghaziabad, Delhi NCR**.

He /She is informed accordingly for further necessary action.

17/5/24

[Dr. EZHILRAJAN. K]
REGISTRAR

SUMIT SINGH
M.Sc Medical Imaging Technology.

Copy to:

1. The Vice Chancellor
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3. The Dean, SMC&H
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6. HOD/ Course In-charge of the concerned Department.

Assessment of age-related changes in the width of the female pelvis

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